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ABSTRACT

This paper reports initial results in the development of an inventory to measure visual reading difficulties. The instrument, called the Word Preference Inventory (WPI), asks the subject to choose between pairs of stimulus pseudo-words the one most like a given target word. An analysis of responses to the WPI from 922 children in grades K-6 and from 102 university students reveals meaningful and homogeneous subsets of items which act as indicators of children who are poor readers. The distribution of such scores indicates that good readers will score high on the subsets whereas subjects who are poor readers may have low scores. A developmental process, which can be ascribed to reading words, interacts with response choice, however, so that the discriminating power of items varies across grade levels. At any grade level, however, one or more subsets of items can be scored which selectively discriminate poor readers who probably have specific visual strategies for word recognition. (Author/DD)

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Final Report

Project No. 9-I-096
Contract No. OEC-9-71-0019(057)

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THE DIFFERENTIAL MEASUREMENT OF VISUAL READING DIFFICULTY

December 1972

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ABSTRACT

This paper reports initial results in the development of an inventory to measure visual reading difficulties. The instrument, called the Word Preference Inventory (WPI), asks the subject to choose between pairs of stimulus pseudo-words, the one most like a given target word. If, for example, the target word is form the subject is asked to choose which of two error-words, ofrm or fform, looks most like form.

An analysis of responses to the WPI from 922 children in grades K-6 and to 102 University students reveal meaningful and homogeneous subsets of items which act as indicators of children who are poor readers. The distribution of such scores indicates that good readers will score high on the subsets whereas subjects who are poor readers may have low subtest scores.

A developmental process, which can be ascribed to reading words, interacts with response choice, however, so that the discriminating power of items varies across grade levels. An item, for example, that discriminates between good and poor readers in the second grade may fail to discriminate similarly in the 6th grade and vice versa. At any grade level, however, one or more subsets of items can be scored which selectively discriminate poor readers who probably have specific visual strategies for word recognition.

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PREFACE

This study is a continuation of an innovation in measuring children's visual reading strategies initiated and reported by the author earlier (Dunn-Rankin, 1971)*. The innovation consists of utilizing tasks which measure relative preference for errors as opposed to absolute measures. Where the previous work was descriptive the effort in this study attempts to illustrate the predictive ability such measures can have.

I am pleased to acknowledge the help of Maria Lourdes Villanueva in collecting and analyzing the data for this study. The principals, teachers, and staff of the Mahaione Elementary School, Maile Elementary School, Kahala Elementary School, and the University Elementary School in Hawaii were most helpful and cooperative during the data collection. I am also appreciative of the support given to this study by the Hawaii Department of Education.

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*Dunn-Rankin, P. "Analyzing the Development of Reading Skill Using an Error-Word Preference Inventory." A paper presented at the American Educational Research Association Convention, New York, N. Y., February 5, 1971.

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INTRODUCTION

The Problem

The need for effective diagnostic tools in the measurement of reading problems among young children seems imperative. A general diagnosis of reading difficulty is usually determined by the fact that a child has achieved very deficient results in reading and spelling in relation to his other school grades. The diagnostic problem is acute, however, for beginning readers since there are few measures at this level in any areas of achievement which may serve as a baseline for making comparisons. For young children it appears particularly important to differentiate a prognosis of late blooming from that of a specific disability. This would allow remedial measures to be taken before the child's reading problems become masked by emotional ones.

Schiffman (1962) stated that solutions to the complex problem of diagnosing specific reading difficulties lay in refining diagnostic techniques and Money (1962) also indicated a need for new tests that are more accurate and valid in the differential diagnosis of reading disability. Shedd (1968) implied the need for more rapid screening procedures which could be employed by nonspecialized personnel.

It is suggested that the differential diagnosis of visual reading problems may be accomplished by creating instruments which have subjects make similarity judgments between a target word and word pairs displaying different kinds of errors. The analysis of relative performance in these visual recognition tasks should allow teachers to focus instruction more effectively, and a comparison with normal responses on such measures should provide a baseline for the diagnosis of specific reading disabilities.

It is the purpose of this study to construct instruments using relative similarity judgments which will differentially measure visual reading difficulty. A basic assumption behind the use of similarity judgments to diagnose reading skill is that judged similarity is related to visual confusions. The "more similar" choice should have a greater probability of being misperceived for the target when other factors such as frequency of usage, phonetic similarity, and context are held constant. Therefore, if a subject has a choice between two kinds of error-words, his choice should indicate the kind of visual organization he utilizes when attempting to read.

Another assumption in building a diagnostic measure of reading disability is that problems in the visual recognition of words are not evenly distributed across subjects. Presumably different children suffer different types of misperception. Wolfe (1939), for example, found differences between subjects in their response to partial and complete reversals, and illustrated that to some children partial reversals were confused more often than complete reversals.

Theory and Review

Children and adults have been observed to misperceive words when reading orally. Most often some other word is substituted for the printed original. Word substitution errors due to visual misperceptions can be classified into natural groups. If, for example, the word stop is perceived as slop, this perceptual error (as substitution of t for l) is naturally classified as a substitution error. On the other hand, if stop is perceived as pots, this is classified as a reversal of the letters. The words bat and pat are sometimes confused, by beginning readers, and the letters of these words are also seen as highly similar. The confusion between bat and pat, however, is a special kind of substitution error which results because b and p can be made to coincide by rotation.

Money (1966) has illustrated major types of visual perception errors that are characteristic of visual reading problems and presented several classifications under each type. Lecours (1966) has presented a morphology of misspellings which occur among retarded readers. The present author has devised a more extensive taxonomy of possible word confusions based on combinations of these factors. The taxonomy with examples is given in Table 1.

The geometrical similarity between lower case letters of the English alphabet has been investigated (Dunn-Rankin, et al., 1968) and in addition the work of Popp (1963) and Dunn-Rankin (1969) has provided an empirical basis for determining the similarity between lower case letters of the English alphabet. These studies provide a strong rationale for choosing letters which fit the substitution category of the taxonomy given in Table 1.

Basic to the formulation of such a taxonomy is the idea (Carroll, 1964) that a word can be visually constituted as the sum of its parts. The parts in this case are hypothesized to be the letters that form the word. Two words, therefore, with highly similar letters should be misperceived for each other more often than words whose letters are not as perceptually congruent. The words mouth and month or beam and bean are configurally very similar because the letters that form the words are highly similar.

A review of the literature indicates that the early diagnosis of specific visual reading disability is an important problem. The author accepts the proposition that visual errors associated with letter and word recognition can vary widely, and suggests that the relative frequency of various visual perceptual problems are not the same for normal children and children who display symptoms of reading disability.

Table 1

TAXONOMY OF POSSIBLE ERRORS ASSOCIATED WITH THE VISUAL PERCEPTION OF WORDS

ERROR TYPES	EXAMPLES
Letter Order	
a. Simple reversal	saw-was; pot-top
b. Single letter permutation	
1. Beginning	door-odor; scar-csar
2. Middle	trial-trail; scared-sacred
3. End	east-eats
4. First to last	spot-pots; spin-pins
Letter Substitution	
a. Letter rotation	
1. Beginning	pig-big; war-mar
2. Middle	month-mouth; ladle-lable
3. End	tap-tad-tab; beet-beef
4. Multiples	fad-tab; mat-wet
b. Letter misperception	
1. Beginning	not-hot; eat-cat-oat; kind-hind-bind
2. Middle	jelly-jolly; jetty-jolly; all-ail
3. End	tan-tam; hale-halo
4. Multiples	leggy-foggy
Word Change	
a. Addition	
1. Beginning	in-tin
2. Middle	met-meet
3. End	mad-made
b. Deletion	
1. Beginning	those-hose
2. Middle	may-my
3. End	soon-so
Combination of Major Errors	
a. Simple reversal and misperception	net-ton; liar-nail
b. Simple reversal and letter rotation, etc.	tad-bat; war-ram

METHODS AND PROCEDURES

Instrument Construction

The Word Preference Inventory (WPI) was constructed by choosing items which represent the major categories illustrated in the Taxonomy of Word Similarities. This taxonomy is presented in Table 1. The categories used were Letter Order, Letter Substitution, and Word Change. Seven different kinds of errors found in these categories were used:

Category	Error	Definition
Letter Order:	Reversals (REV)	Reverse entire word.
	Permutations (PER)	Transpose adjacent pr. of letters.
	First-to-Last (FTL)	Move first letter to end of word.
Letter Substitution:	Rotation (ROT)	Rotate individual letter.
	Misperception (MIS)	Change individual letter to similar appearing letter.
Word Change:	Additions (ADD)	Repeat a letter.
	Deletions (DEL)	Delete a letter.

Each form of the Inventory (see Appendix A) contains 21 different target words and 21 pairs of error-words which are distortions of their respective targets. The seven types of errors are used to form the pseudowords by permuting, substituting, or changing the letters of the target words. The seven errors were paired in all possible ways with each pair matched against its appropriate target. For example:

(Target word) form — ofrm (Permutation); fform (Addition)

The 21 different pairings were arranged according to procedures developed by Ross (1934).

The target words are all four letters long. The targets in Form A were taken from Rinsland's (1945) word list and are among the most common words used in writing. Words were particularly chosen that adapted themselves to embedding the seven specific errors and preserving a discrimination order previously determined. That is, error words were constructed so that good readers were likely to choose ADD>DEL>MIS>ROT>PER>FTL>REV (Dunn-Rankin, 1971). When letter substitutions were made, letters were chosen which had been shown to be highly similar (Dunn-Rankin, 1969). The letter m was substituted for w (a rotation) and the letter c was substituted for e (a misperception), for example.

Forms B and C are non-phonetic adaptations of Form A in which consonants have been substituted for vowels and in which the position of the error words is reversed. The forms were administered with the oral directions "Circle one word of each pair that looks most like the single word." (See Appendix A for instrument and directions for administration.)

Administration

Based on recommendations from Dunn-Rankin's (1971) earlier work two revisions of the Word Preference Inventory (WPI) were constructed and printed in 14 PT century font. These were administered to elementary school students in 1971. An analysis of the results of these administrations led to the third and fourth revisions of the instrument. The latest version (see Appendix A) was administered to 922 public school children in grades K-6 in the State of Hawaii and to 102 college seniors and graduate students in the Spring of 1972. One month later 106 children in grades 2-4 were retested in the Fall of 1972, another sample of 200 children in grades 4 and 5 were also given the latest revision in October, 1972.

Time to Administer and Omissions

101 students in Introductory Psychology and Statistics classes indicated their starting and finishing times for responding to three forms of the WPI. Their average time to complete the three forms was 3.6 minutes or little more than a minute per form.

Second grade children, on the other hand, took considerably longer to respond. Teachers estimated that their students took from 5 to 15 minutes to complete the three forms. A few children in K, 1, and 2nd grade were unable to complete the task but this was less than one percent of the children in those lower grades.

A check was made on the number of children in the second grade who left more than six percent of the responses blank. Out of 251 students 22 did not respond to five or more items. Table 2 provides the frequency with which each item was omitted by this particular group of 22 students.

Table 2 reveals that as responding progressed a few young children (9%) become fatigued. This suggests that just two forms may be appropriate for this level or that administration should be given over two days. It is also reasonable to expect that individual administration, presenting one item at a time, may be effective with very young or immature children.

Table 2

ITEMS LEFT BLANK BY 2nd GRADE STUDENTS
WHO LEFT MORE THAN 4 ITEMS BLANK (n=22)

Item No.	Frequency	Item No.	Frequency	Item No.	Frequency
	Form I		Form II		Form III
1	1	22	7	43	9
2	1	23	6	44	12
3	1	24	6	45	10
4	3	25	8	46	11
5	1	26	6	47	9
6	1	27	3	48	5
7	1	28	5	49	4
8	1	29	4	50	8
9	1	30	5	51	4
10	1	31	5	52	4
11	2	32	3	53	4
12	1	33	3	54	5
13	3	34	5	55	7
14	2	35	5	56	5
15	1	36	4	57	6
16	2	37	6	58	8
17	4	38	3	59	9
18	1	39	5	60	9
19	2	40	4	61	7
20	2	41	7	62	8
21	2	42	3	73	8
TOTAL	34		103		153
AVERAGE	1.61		4.90		7.28

RESULTS

Unidimensional Scale Analysis

In constructing the WPI each type of error word was contrasted with every other error type. Thus each form consisted of a complete set of paired components. It was, therefore, possible to construct for each subject three profile rank scores, one for each form, and a total profile over the seven error categories (Dunn-Rankin, 1965). For each distinct group of subjects, unidimensional rank order scale scores of error preference were also calculated (Dunn-Rankin, 1969). The groups scale scores are presented in Table 3 and graphically shown in Figure 1.

Table 3

RANK SCALE VALUES OF ERROR WORD TYPES

Group[1]	n	TRANSFORMATION						
		ADD	DEL	MIS	ROT	PER	FTL	REV
K	73	65	58	41	55	55	43	34
1	63	71	58	49	52	57	36	28
2 MES	142	67	44	43	48	62	47	50
2	108	72	53	50	52	58	38	26
3	142	76	51	51	48	58	38	28
4 Samoa	54	74	50	43	52	60	42	29
4	124	80	56	53	50	55	34	21
5	71	80	56	46	44	56	41	27
6	145	82	60	55	53	51	32	18
College Students$_1$	50	81	56	56	50	55	32	21
College Students$_2$	52	76	50	63	55	56	32	18
HES Teachers	25	94	70	62	51	45	23	6

[1]Grades without specified school are all from the Hahaione Elem. School.

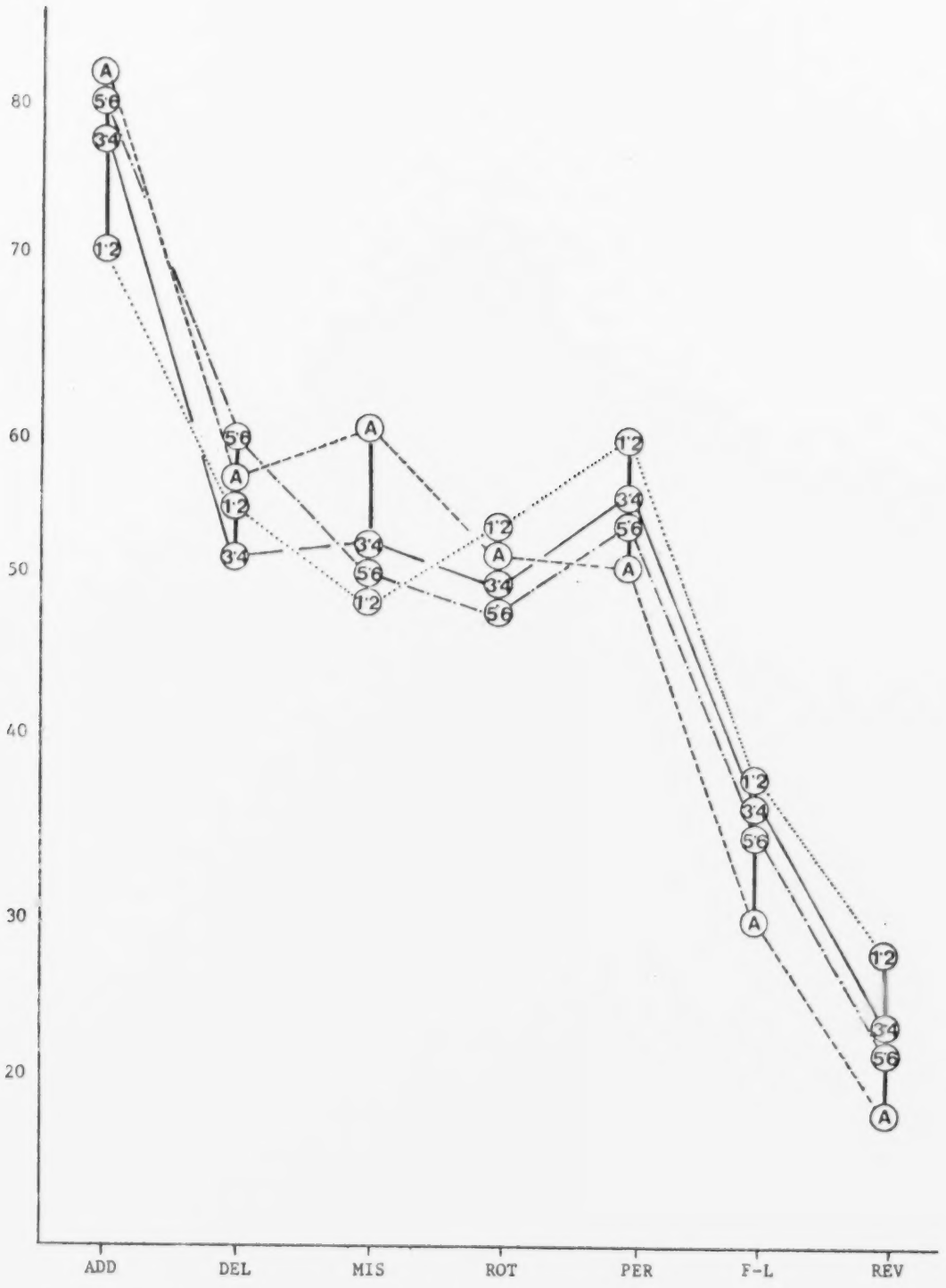

Figure 1. Scale score for error word types are presented across grade levels.

Results of the Unidimensional Scale Analysis

The scales in Figure 1 can be interpreted within a frame of 0 and 100. A scale score of zero would indicate that every subject in the group saw that particular error type as least similar to the target word. A score of 100 would indicate that, in every comparison involving the particular error, each subject chose that particular category as most similar to the target.

In Figure 1 all the adults have been grouped together and adjacent grades from the Hahaione Elementary School have also been grouped so that the presentation is more succinct. It can be observed that Addition error words (ADD) are preferred to Reversals (REV) by all groups. In general the data support they hypothesized discrimination order of preference suggested by Dunn-Rankin (1971) of ADD> DEL>MIS>ROT>PER>FTL>REV. Adjacent letter transpositions (PER), however, have slightly higher overall scale scores than Rotations (ROT).

Where a definite preference of one type of error word is indicated, for example with Additions (ADD), Reversals (REV), and First-to-Last (FTL), a rank order by grade level is observed which may be partially due to more consistent choices being made by the older subjects. Adults are inclined to prefer Misperceptions (MIS) more than elementary school children and beginning readers show relative preference for Reversals (REV) and First-to-Last (FTL) errors and least like Additions (ADD).

It was originally intended to utilize each individual's scaled profile as the basis for determining "types of reading difficulty." It was discovered, however, that some error word categories were not well enough defined to permit profile analysis, i.e., some items within an error category showed greater response variance than items between categories. It was thus possible to get the same score for a category in different ways. Two people, for example, might have the same number of votes for Misperceptions (MIS) in comparison with other errors with one person's votes resulting from choosing Misperceptions (MIS) over Rotations (ROT) and the other's score occurring by choosing Misperceptions (MIS) over Deletions (DEL). The individual profiles, therefore, were not stable enough to act as predictor variables.

Error Word Item Endorsement Discrimination & Reliability

The Reading subtest scores of the California Achievement Test (CAT) and the Sequential Tests of Education Progress (STEP) were used as criterion variables for each item. The CAT was used for grades 2 and 3 and the STEP for grades 4, 5, and 6. For grades 2, 4, and 6 the reading scores had been previously obtained as part of the Statewide testing program within 2 months of the presentation of the (WPI). In grades 3 and 5 reading scores were obtained from administration a year prior to presentation of the (WPI). Discrimination indices in the form of point-biserial correlations were obtained for each item across all grades using the Reading test scores as criterion variables.

For each grade level, kindergarten through adult, endorsement percentages were found for each compare word in the 63 items of the WPI.

Test-retest reliabilities of each item were obtained for 126 children in grades 2-4 who again responded to the instrument one month later.

Table 4 presents error word endorsement percentages, reliability indices, and discrimination indices for each of the 63 items. The items in Table 3 are grouped according to error type in the hierarchical discrimination order theoretically postulated.

Results of Item Analysis

It can be observed that endorsement generally increases with grade, that there is heavier endorsement at all grade levels for Form A which contains phonetic items. There are also significant differences between the endorsement of particular error word types. Items 1, 42, and 43 comparing Additions (ADD) and Deletions (DEL), for example, are much more heavily endorsed by the adults than by lower elementary school children.

The discrimination indices reveal strong differences between the item's ability to discriminate at different grade levels. Items 8, 35, and 50 indicate negative discrimination for grade 2 and positive discrimination in grades 3-6. Items 42, 26, and 21 indicate significant discrimination in the sixth grade but lack of discrimination in grades 3 and 4. Thus the discrimination indices indicate differential responses to items over grade levels.

Table 4

CHOICE PERCENTAGE AND DISCRIMINATION INDICES FOR 63 ITEMS OF THE WORD PREFERENCE INVENTORY OVER GRADES TWO TO SIX

ITEM No.	Description	Grade	ENDORSEMENT PERCENTAGE K	1	2 Lo	2 Hi	3	4	5	6	A	r_{tt} #	DISCRIMINATION INDEX Grade	2	3	4	5	6	TYPE OF WORD TRANSFORMATION COMPARED
		n	73	63	139	108	89	101	47	56	50		n	247	89	101	47	56	
1	pail: paill-ail		82	89	84	90	96	98	91	92	92	.10		.02	.08	.24	.21	.18	
42*	cvvl: ccvvl-vvl		55	67	78	71	86	79	86	82	90	.08		-.01	.12	.10	.10	.12	ADD-DEL
43*	cxxl: ccxxl-xxl		62	70	81	78	86	91	81	80	92	.38		.03	.20	.08	.19	.31	
8	sore: ssore-core		78	81	68	71	70	68	74	81	80	.18		-.08	.17	.25	.26	.08	
35*	dswr: dswrr-kswr		66	71	76	74	86	85	83	81	90	.23		-.09	.33	.36	.16	.21	ADD-MIS
50*	svrz: ssvrz-cvrz		68	68	83	78	73	85	75	84	82	.19		-.04	.13	.22	-.05	.16	
15	ship: shipp-zhip		79	81	67	74	88	91	78	83	82	.28		.06	.40	.32	.08	.13	
28*	stjg: stjgg-ztjg		60	67	68	68	86	85	76	73	84	.13		.06	-.28	-.35	.19	-.06	ADD-ROT
57*	pole: polle-dole		68	63	70	74	59	70	74	76	70	.25		.05	.08	.14	.10	.18	
4*	form: fform-ofrm		45	59	48	67	86	68	79	64	78	.56		.23	.15	.23	.12	.16	
39	fcrm: fferm-cfrm		58	70	55	67	71	77	81	72	66	.07		.02	.17	.07	.26	.09	ADD-PER
46	ksrn: kksrn-skrn		71	62	55	72	71	85	71	66	60	.41		.00	.11	.20	.07	.01	
11*	like: liike-ikel		47	68	63	62	82	72	75	73	80	.29		.03	.02	.24	.14	.12	
32*	cspx: cspxx-xpsc		51	67	59	70	78	79	78	81	82	.26		.03	.18	.13	.03	.29	ADD-F-L
53	cape: capee-apec		84	76	64	77	81	85	81	82	84	.25		.08	.15	.10	.02	.13	
18*	slim: slimm-mils		59	73	63	65	82	83	85	80	88	.45		.08	.28	.19	-.10	.13	
25	stzn: stznn-nzts		70	67	60	63	89	81	77	72	76	.23		.01	.18	.13	.08	.20	ADD-REV
60	nlsp: nlspp-psln		68	73	60	79	89	70	83	69	82	.32		.04	.19	.07	.09	.10	
5*	trip: trp-hrip		70	79	50	54	79	53	57	51	68	.17		-.15	.18	.25	.22	.18	
38	tsxn: tsx-hsxn		74	70	54	67	64	68	65	61	56	.39		.12	.18	.21	-.09	.06	DEL-MIS
47	tnws: tnw-hnws		82	63	61	75	75	81	72	71	60	.38		.17	.32	.25	.15	.02	

No.	ITEM Description		Grade	ENDORSEMENT PERCENTAGE K	1	2_{Lo}	2_{Hi}	3	4	5	6	A	r_{tt} #	Grade	DISCRIMINATION INDEX 2	3	4	5	6	TYPE OF WORD TRANSFORMATIONS COMPARED
			n	73	63	139	108	89	101	47	56	50		n	247	89	101	47	56	
9	burn:	bur-qurn		74	71	60	65	75	68	67	57	64	.22		.01	.05	.19	.15	.16	
34*	bxrn:	bxr-qxrn		52	57	60	59	68	68	64	56	66	.10		-.02	.13	.07	-.03	.23	DEL-ROT
51*	bsdr:	bsd-qsdr		70	67	61	64	79	72	66	65	62	.30		.04	.12	.09	-.10	-.00	
13*	home:	hom-ohme		51	63	47	64	75	68	70	61	70	.41		.13	.11	.11	-.03	.00	
30	hcnr:	hcn-chnr		79	73	45	60	64	70	62	61	58	.15		.16	.10	-.08	.19	-.07	DEL-PER
55*	drug:	drg-rdug		52	60	48	46	64	60	57	52	62	.35		.02	.15	.16	.12	-.07	
17	slow:	slo-lows		55	57	37	45	70	55	62	47	80	.34		.03	-.14	-.32	.00	.09	
26*	slcv:	slc-lcvs		55	57	40	46	57	49	56	48	56	.21		.01	-.26	-.25	.13	.09	DEL-F-L
59*	thcv:	thc-hcvt		66	62	42	48	57	45	54	56	54	.29		.03	.12	-.07	.03	.06	
21	call:	cal-llac		63	65	47	74	88	79	78	74	84	.44		.24	.33	.26	.11	-.04	
22	csll:	csl-llsc		53	60	43	71	79	64	76	66	70	.21		.16	.21	.21	.12	.04	DEL-REV
63*	nsll:	nsl-llsn		49	65	44	60	70	72	46	53	66	.37		-.07	.17	-.14	.07	-.01	
12	best:	hest-qest		42	60	53	70	79	79	78	74	88	.16		.17	.03	-.01	.07	.21	
31*	bcvt:	hcvt-qcvt		26	56	53	57	73	60	71	74	82	.19		.18	-.04	.06	.35	.50	MIS-ROT
54*	boat:	hoat-qoat		21	44	54	55	80	67	70	72	86	.18		-.03	-.06	.02	-.04	.31	
16*	clip:	elip-lcip		29	38	32	44	57	49	49	40	58	.38		.00	.07	-.13	-.03	.01	
27	clnp:	elnp-lcnp		48	44	31	42	50	47	42	45	52	.10		-.01	.11	-.18	.13	-.11	MIS-PER
58	ctnm:	etnm-tcnm		44	43	24	39	48	34	36	31	40	.20		.10	.10	-.24	.06	-.12	
20	have:	bave-aveh		58	62	50	80	70	55	70	63	74	.27		-.33	.17	-.05	-.10	.33	
23*	hsvn:	bsvn-svnh		49	54	52	65	71	51	61	57	72	.23		-.00	.03	-.10	-.07	-.04	MIS-F-L
62*	hcru:	bcru-cruh		40	63	45	47	71	60	65	56	62	.11		-.00	.06	-.06	-.07	.41	
2*	coat:	coct-taoc		75	81	71	76	89	62	74	75	72	.35		-.02	.06	.15	.03	.02	
41	cnst:	cnct-tsnc		81	84	54	76	84	79	88	71	82	.22		.15	.19	.01	.05	.04	MIS-REV
44	nvst:	nvgt-tsvn		67	73	50	72	80	72	20	65	70	.38		.15	.05	.10	.13	.10	
19	must:	musf-umst		74	60	48	65	79	68	68	61	74	.19		.09	.16	-.04	.22	.18	
24*	mwst:	wmst-mwsf		64	52	59	62	73	64	64	70	68	.16		-.05	.14	.08	.16	.10	ROT-PER
61*	find:	finb-ifnd		53	63	53	62	80	64	71	56	72	.40		-.07	.29	.17	.02	.33	

ITEM No.	Description	Grade	ENDORSEMENT PERCENTAGE K	1	2 Lo	2 Hi	3	4	5	6	A	r_{tt} #	Grade	DISCRIMINATION INDEX 2	3	4	5	6	TYPE OF WORD TRANSFORMATION COMPARED
		n	73	63	139	108	89	101	47	56	50		n	247	89	101	47	56	
3*	true: frue-ruet		56	52	52	64	73	47	69	53	72	.38		.16	.05	.13	.04	-.02	
40	trvs: frvs-rvst		62	60	46	54	59	43	54	55	72	.26		-.07	.04	-.04	.08	.07	ROT-F-L
45	fade: tade-adef		59	62	44	66	88	51	73	61	78	.37		.25	.07	.03	.00	.20	
6	jump: juwp-pmuj		73	86	71	83	93	66	86	71	84	.18		.09	.15	.10	.17	-.04	
37*	jzmp: jzwp-pmzj		67	75	63	79	91	81	83	74	86	.28		.19	.12	.03	-.20	.05	ROT-REV
48*	hump: huwp-p uh		67	84	63	80	82	72	75	69	84	.48		-.00	.12	.03	.05	.18	
7	rate: raet-ater		79	97	86	89	95	91	98	88	82	-.03		-.01	.07	.08	.20	.01	
36*	rntx: rnxt-nxtr△		68	87	81	89	86	91	85	91	90	.10		.12	-.07	.16	-.24	.06	PER-F-L
49*	rstx: rtsx-stxr		70	83	74	90	91	94	89	92	94	.21		.05	.09	.26	-.32	.28	
10*	wean: wena-naew		73	89	81	85	93	85	88	82	82	.10		-.01	.10	.25	-.30	-.19	
33	zrsn: zrns-nsrz△		79	81	71	97	89	89	87	85	98	.21		.05	.26	.06	.03	-.03	PER-REV
52	zrsn: zrns-nsrz		84	87	71	90	89	79	87	90	94	.21		.11	.18	.25	.14	.13	
14	slug: lugs-guls		52	59	59	67	77	81	86	72	68	.01		.19	.02	.17	.04	.15	
29	sfng: fngs-gnfs		64	57	55	70	55	68	65	56	68	.21		-.02	-.01	-.06	.13	-.07	F-L-REV
56*	soul: ouls-lous△		48	46	59	44	70	57	53	48	76	.20		-.10	.11	.16	.00	-.06	

* Error word is reversed in the original inventory
△ Wrong permutation of letters
\# Reliability obtained on retesting 126 third and fourth grade students four weeks later

Positional and Phonetic Bias

Positional and phonetic biases were tested by utilizing phonetic items and their equivalent non-phonetic items together which alternated in position, and similar positional response items which differed in phonetic make up. Table 5 illustrates these two parallel situations.

Table 5

ILLUSTRATIONS OF POSITION SET AND PHONETIC BIAS IN GRADES K-6

ITEM NO.		1st POSITION							
		K	1	2	3	4	5	6	A
9 burn:	bur-gurn	74	71	65	75	68	67	57	64
40 trus:	frus-rust	62	60	54	59	43	54	55	72
	AVG%-1	68	65	64	67	55	60	56	68
		2nd POSITION							
34 bxrn:	qxrn-bxr	52	57	59	68	68	64	56	66
3 true:	ruet-frue	56	52	64	73	47	69	53	74
	AVG%-2	54	54	61	70	57	66	54	70
	D_{1-2}	14	15	3	-3	-2	-6	-2	-2

ILLUSTRATION OF PHONETIC BIAS

ITEM NO.		GRADES							
		K	1	2	3	4	5	6	A
P 21 call:	cal-llac-1	52	59	67	77	81	86	72	68
22 csll:	csl-llsc-2	64	57	70	55	68	65	56	68
	D_{1-2}	-8	2	-3	22	23	21	16	0

In the first comparison items 9 (burn: bur-gurn) and 34 (bxrn: qxrn-bxr) differ because one is phonetic and one is not and because the error word types are in different positions. The same is true for items 3 (true: ruet-frue) and 40 (trvs: frvs-rust). When these items are combined to counterbalance the phonetic-non-phonetic characteristic, the responses provide a test of positional bias across grades. Results indicate that approximately 15 percent of the responses in kindergarten and first grade is due to the position of these error words.

The second comparison involves parallel items 21 (call: cal-llac) and 22 (csll: csl-llsc). These items are arranged to counterbalance positional effect and to test phonetic bias across the grades. The results indicate a phonetic bias of 16-25% in grades 3 through 6 for this particular item.

Factor Analysis

A principal components factor analysis was performed on responses to the 63 items by four groups of subjects: first grade, second grade, third and fourth grade combined, and fifth and sixth grade combined. These combinations were made after a perusal of endorsement percentages, discrimination indices, and sample size across the various grades. The results of the factor analyses after varimax rotation are given in Table 6. Table 6 represents five factors selected under Cattell's scree test (Rummel, 1971), the first four of which were dominant in each age group.

Table 6

FACTOR LOADINGS OF 63 ITEMS OF THE
WORD PREFERENCE INVENTORY AFTER VARIMAX ROTATION

	ITEM		GRADES 1	2	3-4	5-6	ITEM TYPE
	Factor I: NO CHANGE IN LETTER ORDER VS. CHANGE IN LETTER ORDER						
4	form:	fform-ofrm	-34	49	60	53	
39	fcrm:	ffcrm-cfrm	66	70	69		ADD-PER
46	ksrn:	kksrn-skrn	65	70	54		
11	like:	liike-ikel	54	43	55	54	
32	cspx:	cspxx-spsc	61	58	74	35	ADD-FTL
53	cape:	capee-apec	57	64	63	24	
18	slim:	slimm-mils	40	46	48	32	
25	stzn:	stznn-nzts	83	66	71		ADD-REV
60	nlsp:	nlspp-psln	66	63	63		
13	trip:	trp-hrip	67	37	61	41	
30	hcnr:	hcn-chnr	54	51	53	26	DEL-PER
55	drug:	drg-rdug	57	48	43	28	
17	slow:	slo-lows	-40	32	36	45	
26	slvc:	slc-lcvs	54	38	52	25	DEL-FTL
59	thcv:	thc-hcvt	66	28	40		
21	call:	cal-llac	63	67	69	55	
22	csll:	csl-llsc	69	71	73	36	DEL-REV
63	nsll:	nsl-llsn	64	57	63	23	
16	clip:	elip-lcip	28	31	37	50	
27	clnp:	elnp-lcnp	26	40	49	26	MIS-PER
58	ctnm:	etnm-tcnm	23	47	46	34	
20	have:	bave-aveh	-40	53	64	51	
23	hsvn:	bsvn-svnh	55	30	58	40	MIS-FTL
62	hcru:	bcru-cruh	56	32	51		
2	coat:	coct-taoc	53	26	54	66	
41	cnst:	cnct-tsnc	43	59	70	30	MIS-REV
44	nvst:	nvgt-tsvn	46	61	61		

Table 6 (Cont.)

FACTOR LOADINGS OF 63 ITEMS OF THE
WORD PREFERENCE INVENTORY AFTER VARIMAX ROTATION

	ITEM		GRADES 1	2	3-4	5-6	ITEM TYPE
19	must:	musf-umst	36	64	69	71	
24	mwst:	wmst-mwsf	33	47	55	34	ROT-PER
61	find:	finb-ifnd	27	33	67	28	
3	true:	frue-ruet	34	28	49	64	
40	trvs:	frvs-rvst	55	51	53	32	ROT-FTL
45	fade:	tade-adef	60	43	74	42	
6	jump:	juwp-pmuj	25	31	51	69	
37	jzmp:	jzwp-pmzj	51	53	69	30	ROT-REV
48	hump:	huwp-pmuh	59	28	64	24	
	% VARIANCE		21.7	14.1	20.3	9.1	
	Factor II: WORD RETENTION VS. WORD AND LETTER DISTORTION						
1	pail:	paill-ail	45		58	40	
42	cvvl:	ccvvl-vvl	65	70	55	65	ADD-DEL
43	cxxl:	ccxxl-xxl	72	70	59	51	
8	sore:	ssore-core	27		58	58	
35	dswr:	dswrr-kswr	62	51	63	58	ADD-MIS
50	svrz:	ssvrz-cvrz	64	57	47	52	
15	ship:	shipp-zhip			61	39	
28	stjg:	stjgg-ztjg	58	48	57	48	ADD-ROT
57	pole:	polle-dole	59	49	26	44	
	% VARIANCE		7.9	4.5	6.3	6.9	
	Factor III: WORD DISTORTION VS. LETTER DISTORTION						
5	trip:	trp-hrip	55	59	46	41	
38	tsxn:	tsx-hsxn	75	74	68	48	DEL-MIS
47	tnws:	tnw-hnws	51	59	54	59	

Table 6 (Cont.)

FACTOR LOADINGS OF 63 ITEMS OF THE
WORD PREFERENCE INVENTORY AFTER VARIMAX ROTATION

	ITEM		GRADES 1	2	3-4	5-6	ITEM TYPE
9	burn:	bur-qurn	69	50	62	38	
34	bxrn:	bxr-qxrn	63	80	60	55	DEL-ROT
51	bsdr:	bsd-qsdr	58	67	64	58	
13	home:	hom-ohme		34			
30	hcnr:	hcn-chnr		44	45		DEL-PER
55	drug:	drg-rdug		40	41	60	
59	thcv:	thc-hcvt		42	49	43	
17	slow:	slo-lows		43	36	29	DEL-FTL
26	slcv:	slc-lcvs		40	29	46	
	% VARIANCE		7.5	7.6	6.3	6.2	
	Factor IV: MISPERCEPTION VS. ROTATION						
12	best:	hest-qest	49	51	52	32	
31	bcvt:	qcvt-hcvt	60	81	49	39	MIS-ROT
54	boat:	qoat-hoat	45	60	35	53	
6	jump:	juwp-pmuj	50		43		ROT-REV
	% VARIANCE		6.0	3.0	3.5	5.1	
	Factor V: PERMUTATION VS. FIRST-TO-LAST & REVERSALS						
7	rate:	raet-ater			.12	.19	
36	rntx:	rntx-nxrt			.41	.62	PER-FTL
49	rstx:	rtsx-stxr			.40	.54	
10	wean:	wena-naew			.14	.30	
33	zrsn:	zrns-nsrz			.03	.37	PER-REV
52	zrsn:	zrns-nsrz			.33	.15	
	% VARIANCE				3.3	5.1	

The initial factor in the first grade is actually composed of two factors obtained from the analysis of that grades data. In this analysis the first two factors were dominated by a positional bias, i.e., top or bottom choice. Embedded within these two positional first grade factors, however, was the dominant Factor I found at all grade levels. The five factors are illustrated in Table 7 and can be described as follows:

Factor I: Maintaining Letter Order. This factor compares error words with no change in letter order against error words in which the letters have been permuted in some way. This is the major factor found at all grade levels. It is strongly affected by primacy in the kindergarten and first grades and by phonetic form in the sixth grade.

Factor II: Word Retention. Factor II contrasts Addition Error Words with distortions of the target word which do not involve permutations. These error types are Deletions (DEL), Misperceptions (MIS), and Rotations (ROT). In this comparison the target word is retained intact in the Addition Error and has a letter added to it. The other errors distort the shape of the word by altering the letters.

Factor III: Partial Word Retention. This factor compares Deletions against Rotations and Misperceptions. It is hypothesized that the retention of the first three letters of the word allows some phonetic mediation from the target word to the Deletion error.

Factor IV: Misperception versus Rotation. The choice exemplified by this factor is between choosing an error word with a distorted letter such as h for b or a rotation such as q for b.

Factor V: Minor Letter Order Changes versus Severe Letter Permutations. In this factor a relative contrast in permutations is made. The factor appears at the fifth and sixth grade levels.

Table 7

DIAGRAMMATIC PRESENTATION OF FACTOR STRUCTURES BY ERROR WORD TYPE

Word Transformation	Selected Item Comparisons	Factors I (24)	II (9)	III (6)	IV (3)	V (6)
ADDITION		ADD	ADD			
			vs.			
DELETION		DEL	DEL	DEL		
				vs.		
MISPERCEPTION		MIS	MIS	MIS	MIS	
					vs.	
ROTATION		ROT	ROT	ROT	ROT	
		vs.				
PERMUTATION		PER				PER
						vs.
FIRST-TO-LAST		FTL				FTL
REVERSAL		REV				REV

PREDICTION

Foldback Analysis

To gain some insight into the ability of various factors to discriminate poor readers, some predictive studies were performed on the original data using sets of items derived from the factor analysis. Except for Factor I, the predictive sets of items consisted of intact factors. The factor are intact since they consisted of all the items which were constructed into the WPI. Each of these items' factorial identity was determined by the comparison of particular error types. Each error type comparison has 3 highly similar items, one from each of the 3 WPI forms.

It was decided to keep Factors II to V intact since the discrimination indices and factor loadings of most of the items in these factors were high and items few, i.e., 9, 6, 3, and 6, respectively.

Factor I originally consisted of 36 items. In this factor, however, item equivalence could not be used since some of error type comparisons have low discrimination indices across all forms of the WPI. Factor I was thus reduced to the best eight error type comparisons consisting of 24 items.

In addition to Factors I to V, a set of highest discriminating items (HDI) and total factor (TF) scores were included as predictor variables. The HDI factor consist of 20 items which have the highest discrimination indices across the grades. The TF consisted of all the items selected for Factors I to V. Table 8 lists the items for each of these predictor variables. These sets of items are as follows:

Factor I: 4-39-46, 11-32-53, 18-25-60, 21-22-63, 2-41-44, 19-24-61, 3-40-45, 6-37-48.

Factor II: 1-42-43, 8-35-50, 15-28-57.

Factor III: 5-38-47, 9-34-51.

Factor IV: 12-31-54.

Factor V: 7-36-49, 10-33-52.

Table 8

WPI FACTOR MEANS, CUTOFF POINTS, AND RELIABILITY MEASURES ACROSS GRADES

Grade	Mean							(Mean--1 SD)							Alpha						
	HD	1	2	3	4	5	Tot	HD	1	2	3	4	5	Tot	HD	1	2	3	4	5	Tot
Foldback Groups																					
K-1, HES	14	16	6	4	1	5	32	10	10	4	2	0	4	24	.75	.86	.77	.67	.54	.59	.88
Gr 2, MES, HES	14	15	7	4	2	5	32	10	8	5	2	1	4	23	.80	.92	.76	.80	.54	.55	.91
Gr 3, HES (Test)	15	16	7	4	2	5	34	11	9	5	2	1	4	26	.81	.94	.77	.71	.54	.18	.92
Gr 3, 4, HES (Retest)	16	19	7	4	2	5	38	12	13	5	2	1	4	26	.86	.95	.78	.74	.39	.68	.94
Gr 4, 5, HES	15	17	7	4	2	5	36	11	11	5	2	1	4	25	.81	.92	.73	.78	.57	.51	.91
Gr 6, HES	16	19	7	4	2	5	38	13	14	5	2	2	4	30	.79	.88	.76	.59	.32	.58	.89
Validation Group																					
Gr 4, 5, KES	16	18	7	4	2	5	37	12	12	6	2	1	4	28	.81	.92	.63	.69	.36	.55	.91

1. With increases in grade level the alphas also increase.

2. There is a tendency for Factor I and total mean scores to increase with grade level.

Internal Consistency. To determine whether Factors I to V and HD were homogeneous sets of items Cronbach's alpha was calculated for each item set by grade. Table 8 indicates that most sets of items are homogeneous but that internal consistency is also determined by the number of items in a factor or set. Thus the HD, Factor I, and total item sets reveal alphas ranging from .75 to .95 with a median of .89. Factors IV and V on the other hand have a median of .54. This reflects the fact that Factor IV consists of just three items and that Factor V is not consistent across all grade levels.

It can be noted that with increases in grade level, the alphas for HDI, Factors I and V and TF increase. The developmental nature of the visual strategies skills represented by the factors are also indicated by the increases of mean scores across the grade levels which are evident in HDI, TF and Factor I.

Regression Analysis. A linear regression analysis for each grade level was performed using Factor I to V items with unit weighing to predict reading achievement scores. This analysis suggested the order of importance of the various factors at the different grade levels but the variance accounted for by the 5 factor configuration averaged 16% which was rather low. A theory of prediction in this instance, however, argues against a linear relationship between a general visual strategy skill and reading achievement. While it can be hypothesized that a person with a low WPI score should be a poor reader it is not true also that a high WPI score should predict a good reader. Students may have effective visual strategy skills and be poor readers for other reasons. Figure 2 substantiates this hypothesis for the total factor scores prediction of 4th grade students reading achievement. In this case a curvilinear distribution results.

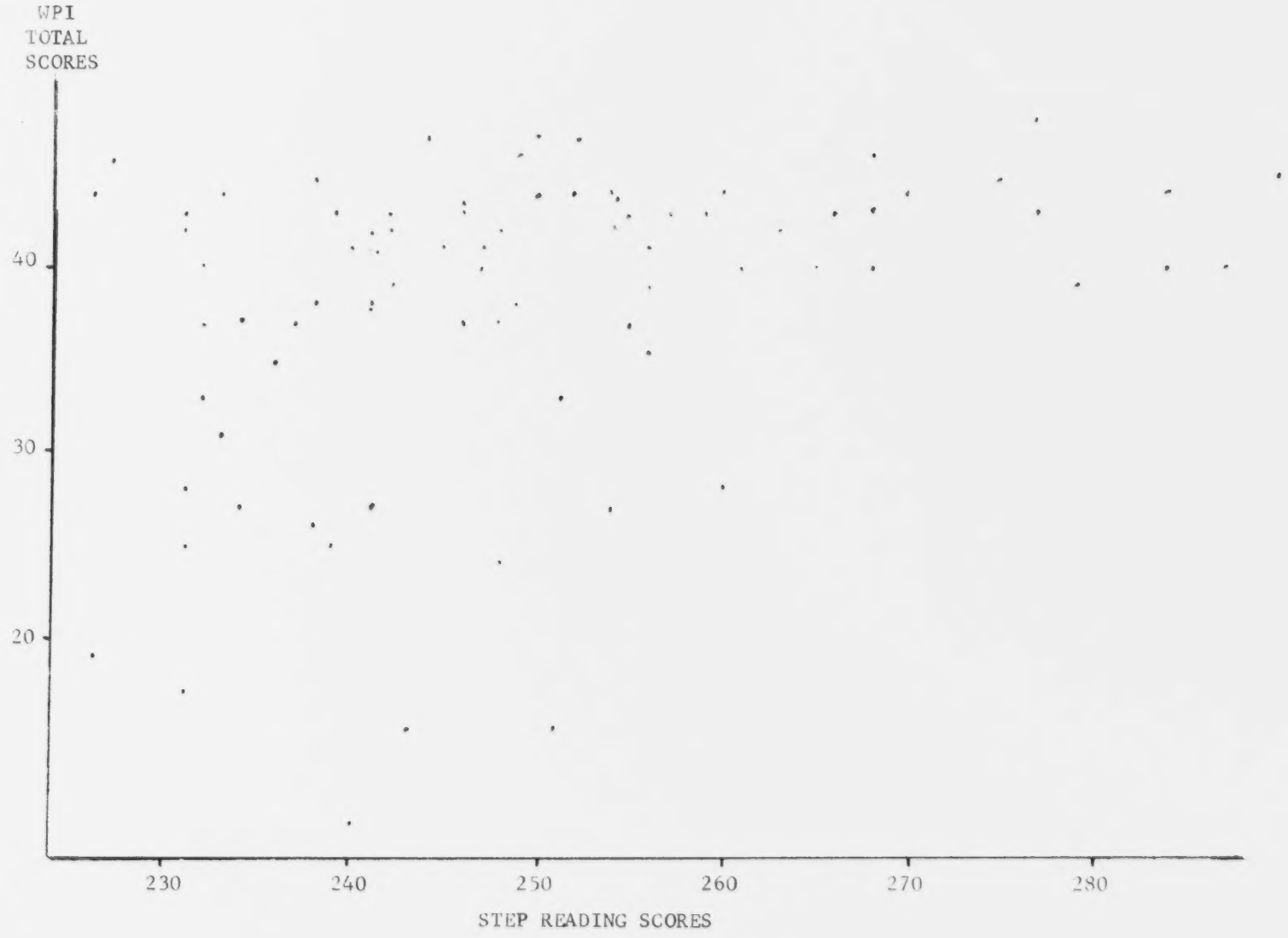

Figure 2. Plot of the Word Preference Inventory Total Scores against STEP Reading Test scores of fourth grade students at Kahala Elementary School.

Because of the curvilinear relationship between visual strategy skills and reading ability, simple prediction rates were obtained for all item sets. The prediction rates indicate the frequency with which a factor score at one standard deviation away from the mean matched a reading score which is below average. Table 9 shows the foldback prediction rates of Factors I to V, TF and HDI across the grades.

It can be noted that the predictive strength of Factors I to V, TF and HDI relative to each other varies from grade to grade. The Grade 2 MES group (which comes from a school low in socioeconomic status and with a greater number of poor readers than Grade 2, HES) has higher prediction rates for Factor II to V and TF. It is more difficult to predict poor readers from a group of generally good readers as observed in Grades 2 and 6, HES.

The prediction rates for HDI and Factor I are high across the grades, averaging 78%. For Grades 4 and 5, HES, the reliability indices are also uniformly high with alphas ranging from .73 to .92. The above results indicate that, excluding Grades 2 and 6, HES, any one set of scores can contribute toward an explanation of poor reading ability in all the other criterion groups insofar as each of these factors reflects specific preference for error types and the degree to which these error types reflect specific visual strategies.

No specific combinations of factors could be observed which resulted in prediction rates which are much greater than those observed from the individual factors. It was noted that the subjects who score low in any three out of five factors is almost invariably a poor reader.

It was also noted that some few subjects with consistently low scores across the five factors tend to have high reading achievement scores. It is hypothesized that while their visual strategy is classified as defective, it is nevertheless consistent or systematic which enables them to utilize a different strategy effectively.

Validation Study

To determine whether the use of Factors I to V, TF and HDI as predictors of reading ability is generalizable to another sample, a validation study on internal consistency and prediction rates was conducted. The validation sample consisted of fourth and fifth graders in Kahala Elementary School (KES). These groups were chosen since their socioeconomic status is similar to that of Hahaione Elementary School (HES) where the prediction rates were uniformly high in Grades 4 and 5.

Table 9

PREDICTION RATES FOR EACH WPI FACTOR

	n	HD	I	II	III	IV	V	Total	3V
Foldback Groups									
2 MES	115	20/26 .77	15/24 .75	16/23 .70	22/31 .71	30/32 .94	22/30 .73	16/22 .73	
2 HES	106	8/8 100	6/6 100	9/21 .43	11/25 .44	9/27 .33	6/15 .40	5/11 .45	
3 HES	137	12/16 .75	11/17 .65	7/13 .54	11/24 .46	7/16 .44	8/16 .57	10/17 .59	
4 HES	124	20/23 .87	13/18 .72	15/18 .83	21/27 .78	15/18 .83	13/15 .87	13/15 .87	
5 HES	66	20/24 .83	6/8 .75	9/12 .75	8/11 .73	12/13 .92	4/7 .57	5/7 .71	
6 HES	125	0/2 --	1/2 .50	3/13 .23	1/7 .42	9/23 .39	1/6 .17	2/7 .29	
Validation Groups									
4 KES	92	8/11 .73	10/13 .77	8/13 .62	11/17 .65	9/15 .60	9/10 .90	10/12 .83	5/6 .83
5 KES	77	24/29 .83	22/28 .79	27/41 .66	24/36 .67	22/32 .69	26/32 .81	25/30 .83	10/10 100

Except for Factor IV, the alphas of Grades 4 and 5 KES are as high as those of Grades 4 and 5 HES. Since Factor IV's relatively low alpha is dependent on its few items, a comparison of the average item factor reliability between the two samples was made. The KES Factor IV item scale mean reliability coefficient is .67 and that of HES is .74. The Factors TF and HDI of the validation sample is as internally consistent as those of the original sample.

The prediction rates of the KES groups (see Table 9) are in the same range as the HES groups, except for Factor IV and V of Grade 3. This difference probably indicates the specific and varied nature of the reading difficulties reflected by a low reading score.

The factor structure derived from the original samples together with the HDI and TF item sets are internally consistent and efficient in predicting reading ability in another sample. The use of these variables are generalizable from the original samples to the validation samples. In fact, by using any three low factor scores the prediction rates for the validation samples are 83% and 100% for Grades 4 and 5, respectively. It is noted that the 3 variable criterion selects 15 children out of 169 as having deficient reading strategies or apparently 11% of a high socioeconomic population.

Discussion of Factors as Predictors. The following discussion is based on a subjective analysis of the results of both the foldback and validation studies.

Factor I (No change in letter order vs. permutations). This factor is a better predictor of poor reading with less stringent cutoffs because it has been observed that a few bright and capable children can utilize a strategy that includes permutations and be successful readers. These bright students show a preference for Reversals (REV), for example. The majority of students, however, cannot deal effectively with such distortions and a general preference for permutation errors generally indicates immaturity in perceptual attack, i.e., a reliance on letters instead of letter groups to determine meaning.

Factor II (Word or unit retention (ADD) vs. minor distortions in the unit DEL, MIS, ROT). This is the best overall prediction of visual reading ability. In this factor the addition of a letter does not bother the good reader because he is able to see the target form embedded with the error word, fform, for example. The poorer reader is unwilling to accept the addition to word length and prefers rather minor distortions of the target word such as for, ferm, or torm, for example.

Factor III (General phonetic mediational identity (DEL) vs. minor distortions in the unit (MIS, ROT)). In this factor a letter is deleted (DEL) and the better reader chooses this distortion because of its beginning letters and because its phonetic identity is largely preserved.

Factor IV (Misperceptions vs. Rotations). The more adult reader sees greater distortions in rotating a letter such as b to q than a highly similar substitution such as h indicating word conscious approach to reading instead of a letter conscious attack.

Factor V (Permutations vs. First-to-Last and Reversals). Permutations appear to be a relatively less severe error than Reversals to the better reader perhaps indicating a left to right scanning ability has been developed.

DISCUSSION

Developmental Process

That visual reading strategies are developmental whether learned directly or inferentially is supported by the increased endorsement for certain error word types as children grow older. While it is true that a more consistent response is also expected with increased maturity some endorsement percentages between error word types are so large that developmental differences can be assumed.

The differences between beginning readers and upper elementary school readers with regard to phonetic and positional bias also reflects the learning and perceptual adjustments that students make as they become more proficient readers. The speed with which educated adults can visually process and respond to the WPI items also illustrates an ability which has become highly developed.

Strong hierarchical endorsements for the error words that retain letter order by sixth graders and adults suggests a developmental process in reading which involves an integration of larger units than letters. Additions particularly indicate the better and older readers ability to disregard letters attached to the word as superfluous.

There is a surprising difference between adults and sixth graders endorsement of Rotations when compared with Permutations, First-to-Last, and Reversal errors. This difference indicates that sixth grade students are still in a developmental process with regard to subtle distinctions between words and have yet to reach the skill possessed by college seniors. The adults have adapted to small changes to a letter in a word whereas many sixth graders still prefer changes in letter order in this comparison.

Consistency of choice also appears developmental. A lack of consistent choice behavior can be postulated for both the preschool and first grade children. Older children show more consistency in their individual profiles and this is reflected in the group profiles which are generally ordered by age.

Contrary to the usual pattern, a few exceptionally bright students have profiles with consistent preferences for pseudowords whose letters, while permuted, are the same as the target, i.e., Reversals. It is suggested that these subjects may be able to solve the reading problem with a consistent visual stragety or are highly analytical in their reaction to the tasks of the WPI.

Since the task is a cognitive appraisal in which the student is allowed to take as much time as he wishes, the bright student may count the letters as a measure of congruence or combine such counting with spatial similarities by equating rotations etc. While he knows the difference between b and p he may analytically equate them in his particular search for similarity, for example.

The discrimination indices reveal the interaction of item response with increases in age. Some items that discriminate within a specific grade level do not discriminate at some other grade level. This indicates the difficulty of utilizing the same sets of items or kinds of items as predictors across all grade levels.

The discrimination between Addition and Misperception errors in the second grade, for example, is unanimously negative. This indicates that the better readers in the second grade preferred Misperception to Addition errors whereas the reverse is true in the third grade and above. This may indicate that children in the second grade are still letter-conscious readers. It does indicate that radical changes are taking place in the visual strategy habits of youngsters at this age and grade level.

If visual strategies are developmental then particular items that discriminate between good and poor readers at the sixth grade level will not discriminate between good and poor readers at the second grade level or between good readers at the sixth grade level and poor readers at the second grade level.

The difference between good reading adults and good reading upper level elementary school children is one of degree in almost all categories. The difference between good and poor elementary readers does not appear with Deletions and Permutation errors. Rotations appear to have small effect in the discrimination between good and poor elementary readers.

Older readers are influenced by phonetic similarity in the strong vowel words. If phonetic similarity and figural similarity are found in the same word older readers will most often choose the error word that combines them.

Prediction Model

Because the WPI measures a specific kind of potential reading difficulty, it is not expected that all poor readers will respond negatively to the factors of the instrument. Some students may have good visual strategy but be poor readers for a variety of other reasons. Thus for most youngsters such skills are necessary but not sufficient for effective reading.

The ability of the WPI to predict poor readers in the 4th and 5th grade from the low scores of the WPI suggests it usefulness as a screening device in the selection of students with developmental lags in their visual processing skill. The analyses and cross validation, however, were done with children in schools with high socioeconomic levels. Better predictions should occur with a broader cross section of children. It therefore appears that with some augmentation to revision of the WPI that the instrument will reliably indicate visual processing levels and word perception strategies of elementary school youngsters.

Criticism of this study can be found in the appraisal of its validity and reliability. One can object to the California Test and the STEP Reading Tests as inappropriate definitions of reading. It might have been better to have correlated the WPI with other diagnostic measures of reading in order to clarify the nature of the instrument. We hope to do this in future studies. Since the WPI appears to measure a developmental process, using reading test scores one year old alters the validity indices to an unknown degree for children in the third and fifth grades.

The reliability of some of the individual items is not extremely high and therefore Factors II, III, IV, & V consisting of nine, six, three, and six items should be proportionately less reliable than Factor I. This can be corrected in the future by enlarging the number of parallel items in these factors.

While sets of items were selected which had high overall discrimination ability the conglomeration is not theoretically meaningful except that the items were all concerned with visual processing.

Recommendations for Further Development of WPI

It is recommended that (1) an improved version of the WPI be constructed that increases the number of discriminating items in Factors II, III, IV, and V, (2) the revised instrument be administered to a wide range of children and adults at all grade levels, (3) relationships between other diagnostic inventories of reading be studied and (4) the usefulness of the WPI as a screening device be further explored.

Implications for Instruction

The observed developmental trend in children's responses to the WPI implies that specific reading disabilities reflect immature or poorly organized strategies of visual-cognitive processing. The implications for instruction indicate that instead of leaving young children to their own devices when recognizing words they should be taught efficient visual processing strategies.

Young children have generally been led to use their own experientially developed visual-cognitive nmenomics or strategies in remembering letters, sets of juxtaposed letters, and words. When a child is presented with a picture of a letter and given its name or sound at approximately the same time, little attention is paid by the instructor to pointing out the features that are efficient for later recognition. If, for example, a card with the letter b is presented and the child is told that this is a "Beee" the child may remember that it is a b because there is a dead fly on the card. Such a strategy is inefficient for use with other cards or places that contain only the letter b.

The emphasis on letter recognition for preschools by most middle and upper class parents and its continued emphasis in the kindergarten, first and second grade as suggested by this study may develop response sets which are difficult to overcome later on. It seems quite clear that many young children in the early elementary grades are strong letter-conscious readers. The clues for their word recognition are the letters attended to as separate and distinct entities.

This is because the younger child's limited experience with words restrains the use of context or phonetic clues as an aid in word identification. Thus the cues of word recognition are predominately the visual symbols presented and the young reader is set to concentrate on the individual letters which form the word in order to make its identification.

The preference of older readers for Addition errors over Reversals seems related to the better readers preference for a left to right scanning of the word and the retention of a global quality accorded the stimulus. One might call it "word integrity" or a "gestalt" and the better reader is more likely to object to the distortion of this gestalt. The visual concept of a word becomes an integrated and ordered set of letters. Extreme letter permutations represented by Reversals and First-to-Last are more disturbing to the more mature reader than other kinds of word distortions.

It therefore seems clear that most skillful readers attend to larger units than letters, perhaps a unit close to syllables. This author suggests 3 ± 2 letters for most reading units. The processing speed of the adult readers on the WPI and their heavy endorsement of additions and non-permutted error words suggests a global quality to well learned words and syllables that replaces letter clues in word recognition.

The results of this study suggest that larger units than letters should be introduced into reading instruction at an earlier time and the important features of such units should be specifically taught. These recommendations require that such reading units be isolated and that their distinctive features be defined. Future research should be directed to isolating the distinctive features of reading units consisting of combinations of English letters.

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Appendix A

LOOK-ALIKE WORDS

READ THE FOLLOWING DIRECTIONS :

This is an exercise to find out what words look alike.

In the following pages, you will find boxes which contain words. Each box has a "target" word to the left and two "compare" words to the right. You are to CHOOSE ONE "COMPARE" WORD WHICH IS MOST LIKE THE "TARGET" WORD IN EACH BOX.

Samples A and B

Look at the box for Sample A.

In Sample A, the "target" word is play. Look at the two "compare" words, yolp and poly. Which of them looks most like play? Circle the "compare" word you have chosen.

Go to the next box.

In Sample B, circle the "compare" word which is most like the "target" word desk.

A	play	yolp poly
B	desk	dske bske

If the directions are not clear, ASK THE EXAMINER TO EXPLAIN THEM TO YOU.

ADDITIONAL DIRECTIONS :

Fill out the blanks on top of every page. Print clearly.

Then read the directions which will remind you what to do and begin to answer the first box. Continue working until you reach the last box of the page. REMEMBER: DO NOT SKIP ANY BOXES AND CHOOSE ONLY ONE OF THE "COMPARE" WORDS IN EACH BOX. Unless the Examiner tells you to do otherwise, go to the next page whenever you finish working on a page.

A

Name_____

Age_____ Grade_____

Sex_____ Date_____

_____

_____

DIRECTIONS: In every block circle one "compare" word of each pair that looks most like the "target" word. DO NOT SKIP ANY PAIRS!

jump juwp pmuj	slug lugs guls	
rate raet ater	ship shipp zhip	
sore ssore core	clip lcip elip	
pail paill ail	burn bur qurn	slow slo lows
coat taoc coct	wean naew wena	slim mils slimm
true ruet frue	like ikel liike	must musf umst
form ofrm fform	best hest qest	have bave aveh
trip hrip trp	home ohme hom	call cal llac

B

Name_____

Age_____ Grade_____

Sex_____ Date_____

_____

_____

DIRECTIONS: In every block circle one "compare" word of each pair that looks most like the "target" word. DO NOT SKIP ANY PAIRS!

clnp elnp lcnp	dswr kswr dswrr	
stjg ztjg stjgg	rntx ntxr rnxt	
sfnq fnqs qnfs	jzmp pmzj jzwp	
csll csl llsc	hcnr hcn chnr	tsxn tsx hsxn
hsvn svnh bsvn	bcvt qcvt hcvt	fcrm ffcrm cfrm
mwst wmst mwsf	cspx xpsc cspxx	trvs frvs rvst
stzn stznn nzts	zrsn zrns nsrz	cnst cnct tsnc
slcv lcvs slc	bxrn qxrn bxr	cvvl vvl ccvvl

C

Name_____

Age_____ Grade_____

Sex_____ Date_____

_____

_____

DIRECTIONS: In every block circle one "compare" word of each pair that looks most like the "target" word. DO NOT SKIP ANY PAIRS!

hump pmuh huwp	soul lous ouls	
rstx stxr rtsx	pole dole polle	
svrz cvrz ssvrz	ctnm etnm tcnm	
cxxl xxl ccxxl	bsdr qsdr bsd	thcv hcvt thc
nvst nvgt tsvn	zrsn zrns nsrz	nlsp nlspp psln
fade tade adef	cape capee apec	find ifnd finb
ksrn kksrn skrn	boat qoat hoat	hcru cruh bcru
tnws tnw hnws	drug rdug drg	nsll llsn nsl